BERICHTE
aus dem MARUM und dem Fachbereich Geowissenschaften der Universität Bremen

No. 310

Fischer, G.

Bouskri, G., Dia, A., Flintrop, C., Hüttich, D., Iversen, M., Klann, M., Konrad, C., Park, E., Ruhland, G., Van der Jagt, H.

Report and preliminary results of R/V POSEIDON cruise POS495

Las Palmas (Canary Islands) – Las Palmas (Canary Islands)
18.02.2016 – 02.03.2016

Berichte, MARUM – Zentrum für Marine Umweltwissenschaften, Fachbereich Geowissenschaften, Universität Bremen, No. 310, 29 pages, Bremen 2016

ISSN 2195-9633

Berichte aus dem MARUM und dem Fachbereich Geowissenschaften der Universität Bremen

published by

MARUM – Center for Marine Environmental Sciences
Leobener Strasse, 28359 Bremen, Germany
www.marum.de

and

Fachbereich Geowissenschaften der Universität Bremen
Klagenfurter Strasse, 28359 Bremen, Germany
www.geo.uni-bremen.de

The "Berichte aus dem MARUM und dem Fachbereich Geowissenschaften der Universität Bremen" appear at irregular intervals and serve for the publication of cruise, project and technical reports arising from the scientific work by members of the publishing institutions.

Citation:

Fischer, G., Bouskri, G., Dia, A., Flintrop, C., Hüttich, D., Iversen, M., Klann, M., Konrad, C., Park, E., Ruhland, G., Van der Jagt, H.: Report and preliminary results of R/V POSEIDON cruise POS495, Las Palmas (Canary Islands) – Las Palmas (Canary Islands), 18.02.2016 – 02.03.2016. Berichte, MARUM – Zentrum für Marine Umweltwissenschaften, Fachbereich Geowissenschaften, Universität Bremen, No. 310, 29 pages. Bremen, 2016. ISSN 2195-9633.

An electronic version of this report can be downloaded from:
http://nbn-resolving.de/urn:nbn:de:gbv:46-MARUM9

Please place requests for printed copies as well as editorial concerns with reports@marum.de

BERICHTE AUS DEM MARUM UND DEM FACHBEREICH GEOWISSENSCHAFTEN
DER UNIVERSITÄT BREMEN

Report and preliminary results of R/V POSEIDON cruise POS495

Las Palmas (Canary Islands) – Las Palmas (Canary Islands)
18.02.2016 – 02.03.2016

Fischer, G.,

Bouskri, G., Dia, A., Flintrop, C., Hüttich, D., Iversen, M., Klann, M., Konrad, C., Park, E., Ruhland, G., Van der Jagt, H.

2016

Table of Contents

1 Participants

Name	Discipline	Institution
Fischer, Gerhard, Dr.	Chief Scientist	GeoB, MARUM
Bouskri, G.	Observer Morocco	UR
Dia, Abdoul	Observer Mauritania	IMROP
Flintrop, Clara	Scientist	MPI
Hüttich, Daniel	Technician	MARUM
Iversen, Morten, Dr	Marine Microbiology	AWI/MARUM
Klann, Marco	Technician	MARUM
Konrad, Christian	Engineer	AWI/MARUM
Park, Eumni	Scientist	AWI/MARUM
Ruhland, Götz	Technician	MARUM
Van der Jagt, Helga	Biology	AWI/MARUM

MARUM	Center for Marine Environmental Sciences, University of Bremen, Germany
GeoB	Geosciences Department, University of Bremen, Germany
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
MPI	Max Planck Institute for marine microbiology, Bremen, Germany
UR	University of Rabat, Rabat, Morocco
IMROP	Institut Mauritanien de Recherches Océanographiques et des Pêches, Nouadhibou, Mauritania

2 Narrative of the Cruise

(Gerhard Fischer)

R/V Poseidon left the port of Las Palmas, Gran Canaria, Spain, on February 18th, 2016 at 9:00 pm on schedule, heading in southwestern direction to the study area off Cape Blanc, Mauritania (Fig. 2.1). We planned to perform optical, microbial, biological and geochemical studies of the water column as well as the exchange of two long-term sediment trap moorings off Cape Blanc (CB and CBi). The mesotrophic mooring site CB is located about 210 nm offshore Cape Blanc and is operated since 1988. It provides one of the longest time series sites for particle fluxes worldwide (Fischer et al., 2016). The eutrophic site CBi has been first deployed in 2003 and is operated since then. Both mooring arrays were deployed during R/V POSEIDON cruise POS481 in February 2015 (see report No. 307, Fischer et al., 2015). During this cruise, we planned to deploy a newly developed Bio-Optical Platform (BOP), equipped with 40 cups for time-series collection of intact marine snow particles (gel-filled cups) and combined with a high resolution particle camera to detect *in situ* particle sinking rates within the sinking tube.

In addition to the installation of sediment trap moorings, we have started to conduct process studies since about one decade. During this cruise, we intended to deploy 2-3 drifting arrays around the eutrophic site CBi with cyclindrical, partly gel-filled traps. They were planned to be combined with a newly developed Infrared particle camera system (IRCam) which can be considered as an improved ParCa system used during earlier cruises (Nowald et al., 2015). To study zooplankton abundance and distribution, we intended to use the multinet with 5 nets, if possible for day- and night hauls to consider dial vertical migration of zooplankton. The studies were completed by roller tank incubation experiments and lab studies with marine snow aggregates collected by the new Marine Snow Catcher (MSC) and different types of zooplankton. This was done to study the effect of zooplankton on particle fluxes and organic carbon degradation ('zooplankton flux feeding'). Respirations rates and sinking rates were determined on marine snow particles from different sources.

On board the cruise were 8 scientists from the University of Bremen (Marum and GeoB) and the AWI (Bremerhaven) and one from the MPI in Bremen. One observer from Morocco (University of Rabat) and one from Mauritania (IMROP, Nouadhibou) joined the cruise.

In the early Saturday afternoon of February 20th, we reached the first station, i.e. the mooring site off Cape Blanc (CB_{meso}) where the sediment trap mooring CB-25 was successfully recovered. The upper trap had worked perfectly, the lower trap had collected only one sample. We then sampled the water column with the rosette-CTD (SBE-5, Geomar, with turbidity). Later we made a first test launch of the new Infrared particle camera to adjust the focus, followed by the deployment of the Marine Snow Catcher (MSC) for the collection of marine snow in shallow water depths (25 m). The

handnet was launched to 50 m to sample zooplankton at night to sample the upward moving zooplankton. Overnight, we deployed the IRCam in 100 m water depths to investigate the abundance of larger marine snow particles and zooplankton during a day-night cycle. After another 1000 m profile with the IRCam in the next morning of Sunday, February 21st, the multinet was launched to 300 m, collecting zooplankton in different depths ranges in the upper water column. In the early afternoon, we deployed the sediment trap mooring CB-27 at our mesotrophic long-term study site. We then sailed about 120 nm overnight to the east to reach the eutrophic study site CBi off Cape Blanc.

On early Monday morning, we could recover the ca. 1500 m long mooring array CBi-13 with two sediment traps which both had worked perfectly. We sampled zooplankton with the multinet in the upper 300 m and launched the Infrared particle camera afterwards. In the early afternoon, the first drifting array DF-13 was deployed with the Infrared particle camera in about 50 m water depth and three cylindrical traps each with 4 cylinders in 100, 200 and 400 m, respectively. One of each cylinder was filled with a special gel to preserve the large and fragile marine snow particles. We launched the Secchi disk, twice the rosette-CTD (down to 100 m and 1000 m), followed by the deployment of the MSC. After dawn, we launched the handnet twice. Finally we deployed the first series of 4 *in situ* pumps (ISP) at the eutrophic study site CBi for overnight sampling of suspended particles in the uppermost water column.

In the early morning of Tuesday, 23rd, we recovered the 4 *in situ* pumps and headed a few miles in southwestern direction to recover the drifting array DF-13 which was in the water for ca. 24 hrs. Close to the array, we deployed the CTD-rosette down to 1000m. After the successful recovery of the drifting array, we deployed the Infrared camera (1000 m). After sailing about 30 nm to the east to the next site, we launched the Infrared Camera, followed by the rosette-CTD. The handnet was used to recover zooplankton from the upper 50 m. Three ISP were deployed overnight. Following the recovery of the ISP the next morning of Wednesday, 24th of February, we redeployed the long term mooring CBi-14 with the Bio-Optical Platform (BOP) and two classical sediment traps. The Infrared Camera was deployed, later the rosette-CTD and the MSC. After the collection of zooplankton with two handnets, we deployed three ISP overnight. On early Thursday morning, we recovered the ISP and sailed 30 nm to the west for deploying the particle camera, first as IRCam, later with usual light. Later, we launched the rosette-CTD down to 1000 m. In the early afternoon of February 25th, we sailed about 75 nm to the east to the last study site close to the coast in about 880 m water depth.

We deployed the IRCam (850 m) on early Friday, February 26th, the multinet (dayhaul down to 300 m), the rosette-CTD and the Secchi disc. We sailed back to the west for about 10 nm (1300 m water depth) to deploy the second drifting array DF-14 with the IRCam and 3 cylindrical settling tubes, partly filled with gels. After sailing back to the site at the 880 m depth contour line, we launched the MSC, twice the handnet, followed by the multinet. Later at night, we deployed three *in situ* pumps in

18, 150 and 400 m water depths to collect suspended particles. We recovered the pumps on early Saturday morning, February, 27th and then headed back for about 10 nm to find and recover the drifting array DF-14. After the launch of the rosette-CTD and the Secchi disc nearby, we recovered the array under rather stormy conditions. We later deployed the IRCam for a depth profile down to 1200 m. In the afternoon, we started to sail back the 500 nm to Las Palmas which we reached in the early morning of March 2nd, 2016.

During the cruise, we launched 51 instruments: Infrared camera (12x), rosette-CTD (10x), multinet (4x), handnet (7x), Marine Snow Catcher (4x), Secchi disc (4x) and *in situ* pumps (4x). Additionally, we performed some testing of a newly developed Infrared Camera system. We recovered and redeployed two long-term mooring arrays with sediment traps (CB-26/27 and CBi-13/14) and set out/recovered two drifting arrays (DF-13/14) with a particle camera (IRCam) and three cylindrical traps each. We had mostly winds of 5-7 Bft and a relatively high swell of 3-5 m throughout the cruise. In summary, we had a successful cruise and we would like to thank Capt. Günther and his crew for supporting us.

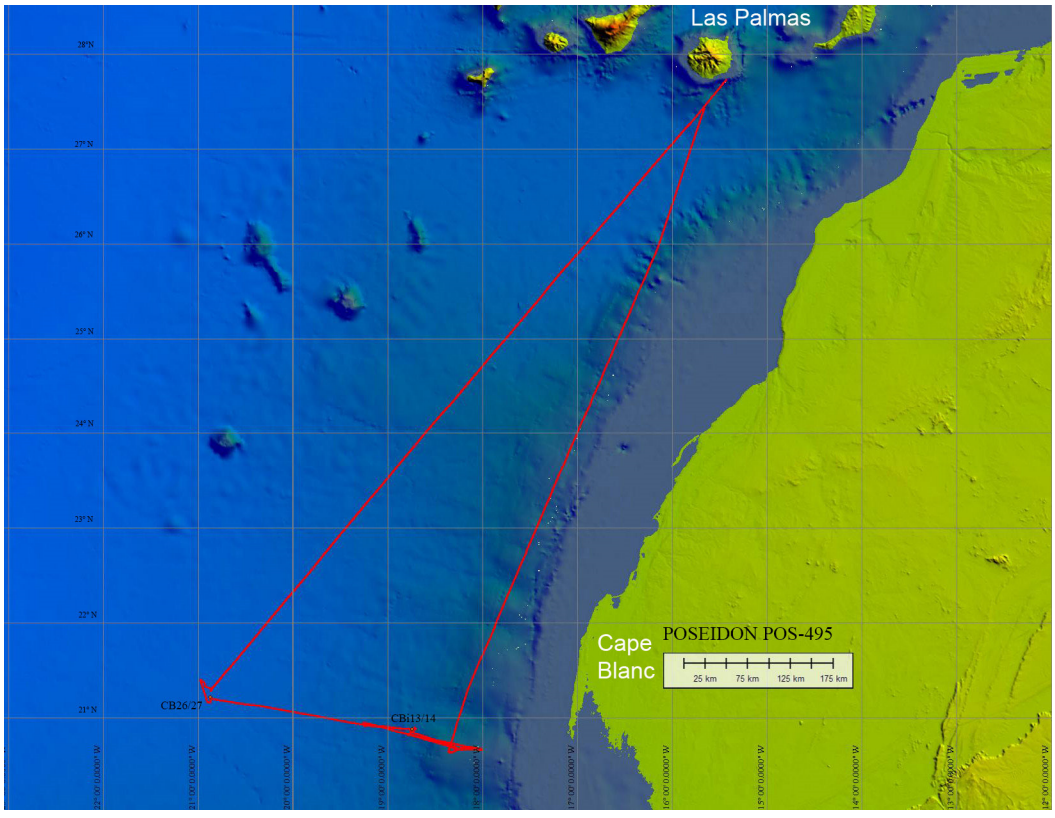

Fig. 2.1 Track and study area of R/V POSEIDON cruise POS495 (Las Palmas–Las Palmas, 18.2.-2.3.2016) with the two long-term mooring sites CB (mesotrophic) and CBi (eutrophic). The tracks of the two drifting arrays DF-13/14 were only a few miles long and cannot be recognized on this scale.

3 Preliminary Results

3.1 Marine Microbiology

3.1.1 Marine snow particles from experiments and the Marine Snow Catcher

(Helga van der Jagt, Clara Flintrop, Christian Konrad and Morten Iversen)

Background

The sedimentation of marine snow aggregates (>0.5 mm) plays an important role in the ocean's carbon cycle. Marine snow aggregates are composed of phytoplankton cells, detritus, faecal pellets and inorganic mineral grains, and by settling the aggregates remove organic matter from the surface ocean layer. Since the organic matter is formed by the fixation of atmospheric carbon dioxide (CO_2) that is absorbed in the surface ocean, the removal of organic aggregates via settling allows for more CO_2 uptake from the atmosphere by the surface ocean. The settling of aggregates is influenced by ballasting minerals, which can increase the sinking velocity of individual aggregates (e.g. Iversen and Ploug 2010; Fischer and Karakas, 2009; Iversen and Robert, 2015.). The influence of ballast minerals on aggregate formation and particle settling have been studied in several laboratory studies, but no studies have focused on the influences from natural ballast minerals (such as Saharan dust) on individual natural aggregates.

The study area off the coast of Cape Blanc (Mauritania) is located in a highly dynamic coastal upwelling system with high primary production. The area receives high inputs of dust minerals via Saharan storms (e.g. Friese et al., 2016). The collected material was used for different studies. First, to estimate the carbon flux at the base of the euphotic zone, we sampled ¼ of the settled aggregates for particulate organic carbon (POC) and chlorophyll-a determination. We also sampled the upper water of the MSC sample to assess the free-living community. Next, we measured individual aggregates to determine their size, sinking velocity and microbial respiration.

Methods and sampling

We deployed the Marine Snow Catcher (MSC, from OSIL, Fig. 3.1) at four locations to sample *in situ* aggregates in or just below the fluorescence maximum layer (Table.3.1). The MSC consists of a 100 l upper part and a removable bottom section. After deployment, the MSC was left standing overnight to let the collected aggregates settle into the bottom section, from which the aggregates can be easily sampled.

To study the effect of the species composition of different layers in the water column on the composition of sinking aggregates, we concentrated water from

different depths over a 25 µm mesh. We sampled the same area with the MSC and concentrated the upper water and fixed several aggregates with formaldehyde. Thereafter, we gently rinsed them with demineralised water to remove salts. Some were put on a smear slide to investigate species and mineral composition while others were embedded in a cryogel to study their structure and bacterial composition. These embedded aggregates will be sliced with a microtome in the home laboratory. Next to sampling *in situ* aggregates, we incubated water from the fluorescence maximum (CTD records, chapter 3.5.1) from the same location in roller tanks, and fixed and measured the formed aggregates in the same way. With this study we will assess the formation and composition of aggregates, and their potential of scavenging organic material while sinking through the water column.

The leftover aggregates of each deployment were used for several incubation experiments with copepods, to study the feeding of copepods on sinking marine aggregates. We filmed encounters of copepods with sinking *in situ* aggregates, and incubated roller tanks with copepods and aggregates, to estimate the feeding of copepods on the carbon flux (zooplankton 'flux feeding').

Fig. 3.1 The Marine Snow Catcher (MSC) from OSIL on board of R/V Poseidon (left). The water volume sampled by the collector is 100 l. Marine snow particles settle downwards into a collector where they can be sampled.

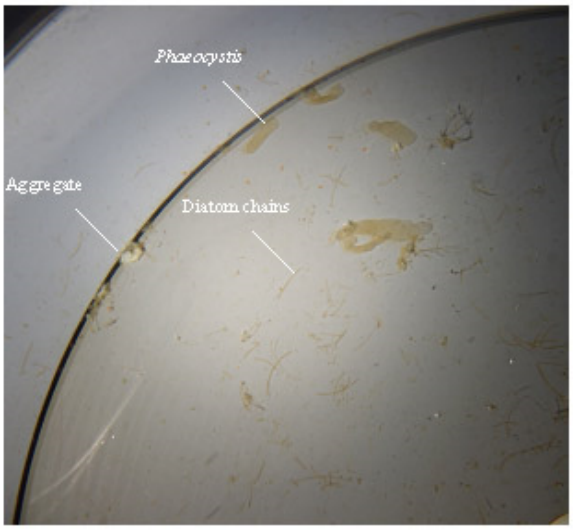

Fig. 3.2 Photograph of a sample taken from the Marine Snow Catcher (MSC) from site GeoB 20709-1 (Table 3.1.) showing mainly large diatom chains, *Phaeocystis spp*, and aggregates.

Table 3.1 List of Marine Snow Catcher (MSC) deployments.

Station No.	Date [dd-mm-yyyy]	Latitude [N]	Longitude [W]	Sample depth [m]
GeoB20701-5	20-02-2016 20:48	21°18.97'	20°53.77'	25 m
GeoB20702-9	22-02-2016 18:28	20°53.54'	18°42.89'	30 m
GeoB20705-4	24-02-2016 19:20	20°52.37'	18°45.94'	20 m
GeoB20709-1	25-02-2016 16:16	20°39.77'	18°00.48	30 m

3.2 Marine Zoology and Micropaleontology

3.2.1 Mesozooplankton collected with the multinet and the hand net

(Marco Klann, Morten Iversen and Gerhard Fischer)

Sampling

We used a multiple net from HYROBIOS, Kiel, fitted with five nets of 200 µm mesh size to sample meso-zooplankton in various depth ranges from the water column in the Cape Blanc area and used standard collection depths of 300-150, 150-100, 100-80, 80-40 and 40-0 m (Table 3.2). We planned to perform day-and-night hauls to account for dial vertical migration of the various species, however, all together only four hauls could be done. This was due to partly rough weather conditions and strong winds of 5-8 Bft throughout off Cape Blanc. Together with plenty of hauls during other Poseidon cruises (POS 425, 445, 464, 481), we plan to investigate the importance of zooplankton (e.g. copepods, euphausiids, appendicularia) for particle degradation in

the upper water column, mainly in the epi- and mesopelagic. Day-and-night profiles were done to determine which species exert vertical diel migration. The collected samples were fixed with formaldehyde and stored cold (4°C).

Table 3.2 Samples taken with the multiple plankton net (multinet, MN) equipped with nets of 200 µm mesh size. Planned standard sampling depths with the five nets were: 1) 300-150, 2) 150-100, 3) 100-80, 4) 80-40 and 5) 40-0 m.

Station No.	Date 2016	Time MN at depth [UTC]	Latitude [N]	Longitude [W]	Water depths [m]	Remarks
GeoB20701-9	21.2.	11:29	21°23.85'	20°58.66'	4226	Standard
GeoB20702-2	22.2.	10:32	20°53.48'	18°43.85'	2744	Standard
GeoB20702-12	22.2.	20:26	20°53.49'	18°42.85'	2731	Standard
GeoB20707-2	26.2.	09:32	20°39.90'	18°00.53'	861	Standard

In addition to the multinet hauls, we made six vertical hauls with a small handnet (Fa. Hydrobios, Kiel). They were made from 50 m water depth up to the surface with a plankton hand net of 75 µm mesh size (see Table 3.3). The hand nets were launched after sunset in order to have as much zooplankton in the surface waters as possible. The zooplankton collected with the hand nets were incubated in roller tanks together with marine snow aggregates and video recordings were made with illumination from infrared light. The goal of these recordings was to capture the feeding behavior of different zooplankton species on marine snow. Several hours of video recordings were made during the cruise, and analysis of the recordings will be performed onshore.

Table 3.3 Samples taken with the handnet (HN) equipped with a mesh size of 75 µm.

Station No.	Date 2016	Time HN at depth [UTC]	Latitude [N]	Longitude [W]	Water depths [m]	Remarks
GeoB20701-6	20.2.	21:00	21°19.02'	20°53.88'	4208	50m
GeoB20702-10	22.2.,	19:57	20°53.55'	18°42.86'	2727	50m
GeoB20702-11	22.2.	20:05	20°53.52'	18°42.84'	2724	50m
GeoB 20705-5	24.2.	19:44	20°52.35'	18°45.96'	2779	50m
GeoB20705-6	24.2.	19:56	20°52.26'	18°45.95'	2771	50m
GeoB20709-2	26.2.	20:06	20°40-03'	18°00.61'	870	50m

3.3 Organic Biogeochemistry

3.3.1 Particulate organic matter and sea surface temperature proxy (TEX_{86}) based on GDGTs

(Eumni Park)

Background

The TEX_{86} (tetra index of tetraethers consisting of 86 carbon atoms), a lipid biomarker proxy, is based on the distribution of isoprenoid glycerol dialkyl tetraethers (GDGTs) in archaeal lipids that are mainly synthesized by marine *Thaumarchaeota*. It has been widely used as a sea surface temperature (SST) reconstruction tool using sediment samples. Recent studies using particulate organic matter (POM) and sediments trap collections in this study area have shown seasonal variations and various GDGTs composition from both core lipids (CLs) and intact polar lipids (IPLs). Especially in the Nepheloid Layers (NLs), the composition of POM and IPLs abundance significantly changed.

Sampling

To have a better insight in these previous results, POM samples were collected at various depths using *in situ* pumps (ISP, McLane Large Volume Water Transfer System, WTS-LV-4/-8) on 142 mm, 0.4 and 0.7 µm GF/F filters (Table 3.4). Surface waters taken from the ship´s seawater inlet were also filtered on 142 mm, 0.7 µm GF/F filters (Table 3.5).

All filters were dried at 40 °C for 24 hour in the oven on board and transported to the home laboratory for future analyses. Lipid extraction and separation processes from POM filters will be carried out and gas chromatography/ mass spectrometry (GC/MS) and high performance liquid chromatography/mass spectrometry (HPLC/MS), operating with atmospheric pressure chemical ionization (APCI), will be used to measure TEX_{86} values based on CL- and IPL - GDGTs.

Additionally, to investigate the diversity of *Thaumarchaeota* and compare the composition of GDGTs in the water column, samples for DNA analysis were taken from the Niskin bottles attached to the Seabird CTD (CTD+ROS, SBE-5) at various depths including water depths where the *in situ* pumps were deployed (Table 3.6).

Water samples for nutrient measurements were also collected from the same Niskin bottles for DNA samples. Those samples were immediately stored at -32 °C freezed and transported frozen to the home laboratory (Table 3.6). The results will give us a detailed picture of the relationship between nutrient conditions and archaean communities derived from the IPL-composition.

Table 3.4 Samples filtered with the *in-situ* pumps (ISP).

Station No.	Date 2016 [dd.mm.]	Latitude [N]	Longitude [W]	Water Depth [m]	Sample depth [m]	Water Volume [L]	Runtime [hh:mm]
GeoB20702-13	22/23.02.	20°53.42'	18°42.84'	2681	80	1057.88	06:30
GeoB20702-13	22/23.02.	20°53.42'	18°42.84'	2681	160	2089.45	06:11
GeoB20702-13	22/23.02.	20°53.42'	18°42.84'	2681	250	926.54	02:51
GeoB20704-3	23/24.02.	20°40.61'	18°16.15'	1324	50	868.14	06:30
GeoB20705-7	24/25.02.	20°52.22'	18°45.83'	2763	40	948.52	07:45
GeoB20705-7	24/25.02.	20°52.22'	18°45.83'	2763	40	1563.69	07:45
GeoB20705-7	24/25.02.	20°52.22'	18°45.83'	2763	40	1563.68	07:45
GeoB20709-4	26/27.02.	20°39.81'	18°00.59'	860	18	1050.61	06:55
GeoB20709-4	26/27.02.	20°39.81'	18°00.59'	860	150	1395.69	06:55
GeoB20709-4	26/27.02.	20°39.81'	18°00.59'	860	400	1395.68	06:55

Table 3.5 POM surface water samples taken from 5 m water depth with the ship's pumping system.

Station No.	Date 2016 [dd.mm.]	Time [UTC]	Latitude [N]	Longitude [W]	Volume [L]	SST [°C]
GeoB20701-2	20.02.	16:45	21°17.26'	20°51.58'	41.4	20.0
GeoB20701-8	21.02.	09:13	21°23.90'	20°58.34'	36.6	20.0
GeoB20702-6	22.02.	15:22	21°53.69'	18°43.01'	39.5	19.4
GeoB20702-13	23.02.	00:19	20°53.30'	18°42.56'	38.0	19.3
Transit	23.02.	15:51	20°48.54' - 20°43.81'	18°43.80' - 18°27.45'	54.6	19.2 - 19.1
GeoB20704-3	24.02.	00:06	20°40.84'	18°16.57'	45.3	17.9
GeoB20706-2	25.02.	13:34	20°55.64'	19°15.40'	58.5	18.8
GeoB20709-2	26.02.	19:05	20°40.02'	18°00.72'	41.6	17.6
GeoB20710-1	27.02.	12:22	20°38.46'	18°20.41'	47.7	17.6

Table 3.6 Samples taken for DNA and nutrients analysis with the Niskin bottles of the rosette (ROS+CTD).

Station No.	Date 2016 [dd.mm.]	Time [UTC]	Latitude [N]	Longitude [W]	Water depth [m]	Sample depth [m]	Nutrients	DNA Water volume [L]
GeoB20701-2	20.02.	17:15	21°18.46'	20°51.94'	4193	23	X	2.06
						33	X	2.10
						54	X	2.10
						60	X	2.00
						100	X	2.00
						400	X	2.00
GeoB20702-6	22.02.	15:55	20°53.60'	18°43.02'	2726	5	X	1.92
						40	X	3.22
						80	X	3.30
						160	X	3.78
						200	X	3.24
						250	X	4.05
						400	X	4.26
						600	X	4.18
						1000	X	3.79
GeoB20704-2	23.02.	22:03	20°40.43'	18°15.72'	1294	5	X	1.67
						50	X	4.29
						100	X	4.77
						150	X	3.81
						200	X	4.00
GeoB20705-3	24.02.	17:39	20°52.35'	18°45.97'	2774	40	X	5.59
						300	X	6.24
						500	X	6.04
GeoB20706-2	25.02.	13:58	20°55.82'	19°15.45'	3352	5	X	3.40
						25	X	4.98
						80	X	5.40
						150	X	6.02
						300	X	6.52
						600	X	6.46
GeoB20707-3	26.02.	10:28	20°39.87'	18°00.43'	854	5	X	5.08
						18	X	7.45
						90	X	7.15
						150	X	5.96
						400	X	6.54
						700	X	6.52
GeoB20710-1	27.02.	11:29	20°38.16'	18°20.33'	1279	5	X	1.80
						20	X	5.15
						60	X	5.34
						130	X	5.01
						300	X	4.94
						729	X	5.24
						808	X	5.68
						850	X	6.57
						950	X	6.92
						1200	X	3.65

3.4 Optical Studies

3.4.1 Vertical profiles of marine snow aggregates with the Infrared Camera system

(Christian Konrad and Morten Iversen)

System description

The Infrared camera (IRCam) consisted of an industrial camera with removed infrared filter (from Basler) that was connected to a single board PC (Raspberry Pi) and a fixed focal length lens (16mm Edmund Optics). Some custom made electronics is included in the system for power configuration and timing. Furthermore a DSPL battery (24V, 38Ah) was used to power the system (Fig. 3.3).

The Raspberry Pi was both used as the operating system for the infrared camera and to acquire the images from the camera and send them to a SSD hard drive where they were stored. The illumination was provided by a custom made light source that consisted of infrared LEDs which were placed in an array in front of the camera. The choice of the infrared illumination was done to avoid disturbing the zooplankton that potentially would feed on the settling particles. With this geometrical arrangement of the camera and the light source we obtained shadow images of particles through the water column. The field of view was 24x36 mm and a depth of field of ~24 mm resulting in a volume of approx. 20 ml. We captured 3 images per second and lowered the IRCam with 0.3 meters per second (lowest possible speed of winch), which resulted in a total imaged water volume of 200 ml per meter. We allowed the camera to obtain images for 5 minutes at 10 m depth and at the 1000 m, which will allow us to estimate the statistical errors induced by the relatively small water volume captured per depth.

Sampling

We made 12 vertical profiles with the IR-Camera and Profile 01 (to 20 m) was used for calibration (Table 3.7). We had some software issues during Profile 02 and only managed to record the downcast. This problem persisted during the Rope 01 and the Profile 03 deployment. Later we were able to fixed the software issue and all subsequent deployments were successful.

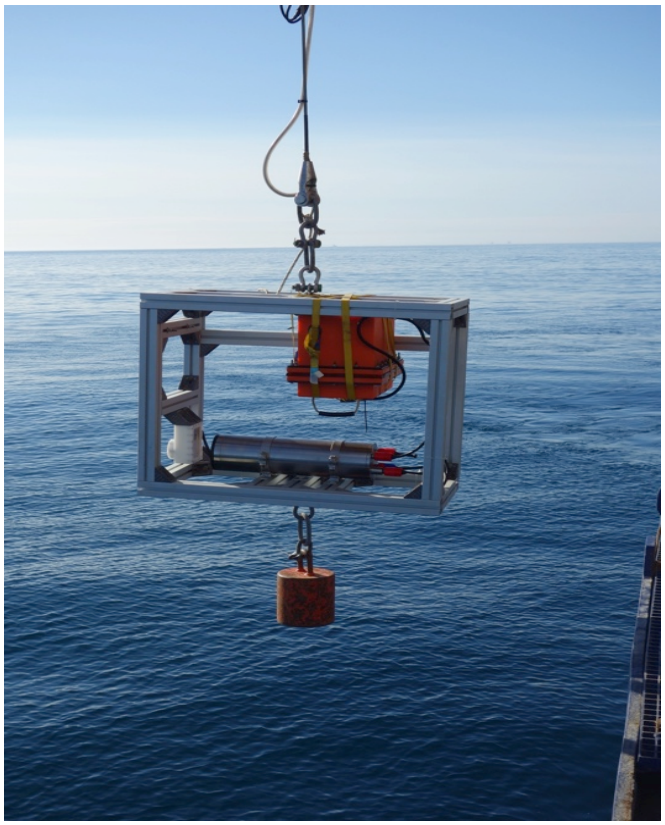

Fig. 3.3 Deployment of the Infrared camera (IRCam), consisting of an industrial camera and lens with electronics, an infrared light source and the DSPL battery.

Table 3.7 List of stations where the Infrared camera (IRCam) was deployed in the profiling mode and within the drifting array DF-13 and DF-14.

Number	Station	Date 2016	Deploy time	LAT	LONG	Water depth	Profiling depth/ wire length	Drifting array
[#]	[#]	[MM-DD]	[UTC]	[° N]	[° W]	[m]	[m]	[#]
Profile 01	GeoB20701-3	02-20	18:25	21°18.57'	20°52.50'	4185	20	
Profile 02	GeoB20701-4	02-20	18:44	21°18.74'	20°53.12'	4183	1000	
Rope 01	GeoB20701-7	02-20	21:19	21°19.07'	20°54.04'	4208	100	
Profile 03	GeoB20701-8	02-21	09:18	21°23.91'	20°58.52'	4227	1000	
Profile 04	GeoB20702-3	02-22	11:01	20°53.51'	18°43.52'	2743	1000	
Drift 01	***GeoB20702-5***	***02-22***	***14:34***	***20°53.28'***	***18°43.47'***	***2733***	***50***	***DF-13***
Profile 05	GeoB20703-3	02-23	13:53	20°49.09'	18°47.06'	2798	1000	
Profile 06	GeoB20704-1	02-23	20:05	20°40.14'	18°15.33'	1270	1000	
Profile 07	GeoB20705-2	02-24	15:52	20°52.38'	18°45.93'	2776	1000	
Profile 08	GeoB20706-1	02-25	12:03	20°55.44'	19°15.25	3339	1000	
Profile 09	GeoB20706-3	02-25	14:52	20°56.41'	19°15.60'	3358	1000	
Profile 10	GeoB20707-1	02-26	08:03	20°40.08'	18°00.59'	871	850	
Drift 02	***GeoB20708-1***	***02-26***	***13:38***	***20°39.93'***	***18°15.08'***	***1267***	***50***	***DF-14***
Profile 11	GeoB20710-4	02-27	13:58	20°38.34'	18°21.70'	1316	1200	

3.4.2 Using the Bio-Optical Platform to study long-term aggregate dynamics

(Christian Konrad, Götz Ruhland and Morten Iversen)

System description

We developed a new method to follow aggregate dynamics throughout a whole year by combining *in situ* optics with gel-filled cups for the collection of fragile marine snow particles. The Bio-Optical Platform (BOP) uses an optical system to determine size-distribution, abundance and size-specific sinking velocities of settling particles every day, throughout a whole year. Additionally, it collects the settling particles in a viscous gel over different time intervals throughout the year. The BOP system is based on a modified sediment trap (Fa. KUM GmbH), where we have replaced the collection funnel with a polycarbonate cylinder to avoid that the settling particles are sliding down the sides of the funnel, which would change their physical structure. The polycarbonate cylinder has an inner diameter of 35 mm and functions as a settling column and allows us to measure the settling velocities and sizes of the particles without interference from ocean currents (Fig. 3.4). This is done with a camera system that is placed at the lower part of the settling column. The camera system consists of an industrial camera (Fa. Basler), a fixed focal length lens (Fa. Edmund Optics) and the system electronics consisting of single board computer (Raspberry PI), including a SSD hard disc and custom made power and time management circuitry. The images are illuminated by a custom made visible light source providing backlight. The whole camera system is powered by a Li-Ion battery (24V, 1670Wh, Fa. SubCTech GmbH) (Fig. 3.5). The camera system makes 5 min of recordings every day. Once the particles have settled through the settling column they are collected in cups filled with a viscous gel that preserves their size and physical structure. The gel-filled cups were placed on two rotation tables capable of carrying 40 gel cups (Fig. 3.4).

The geometrical configuration of the camera system enables daily recordings of shadow images of the particles within the settling column throughout a whole year. It is programmed to take one image per second for five minutes every day throughout one year (Table 3.8). The system was deployed as part of the CBi-14 mooring. The final position and configuration of the mooring is given in the mooring section (see also station list, Table 3.11 and chapter 3.6.2).

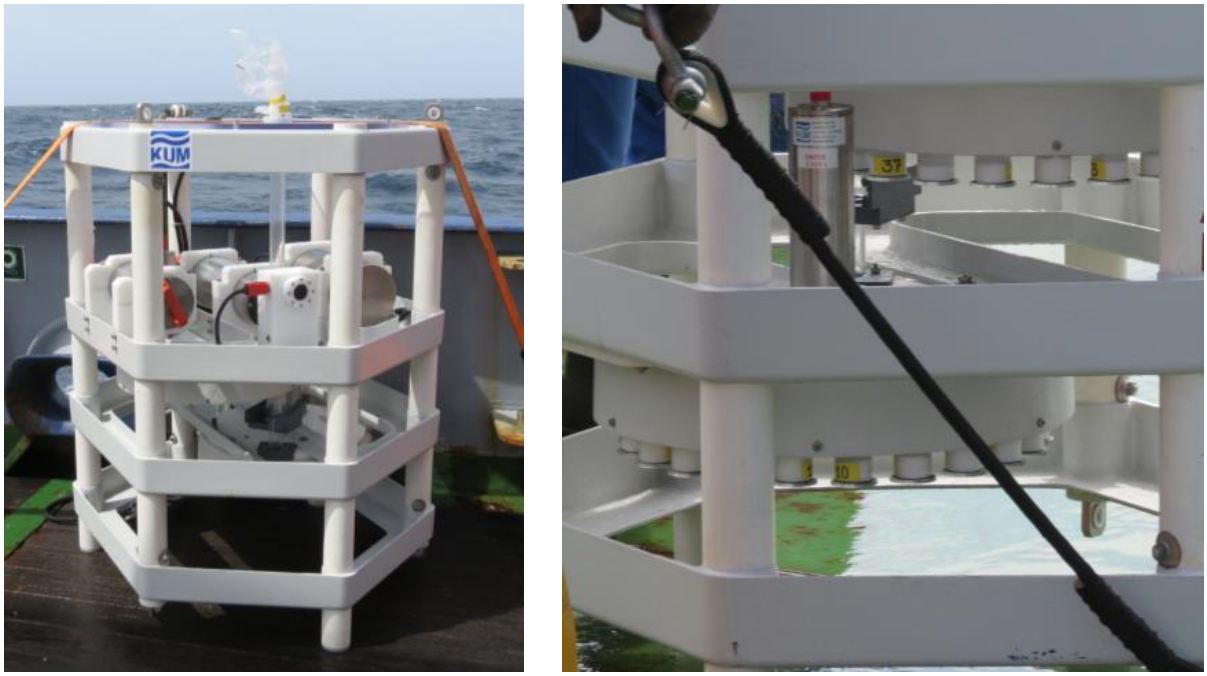

Fig. 3.4 The BOP system with the polycarbonate settling column (left image) and the two rotation tables with the sampling tubes filled with gels (right image).

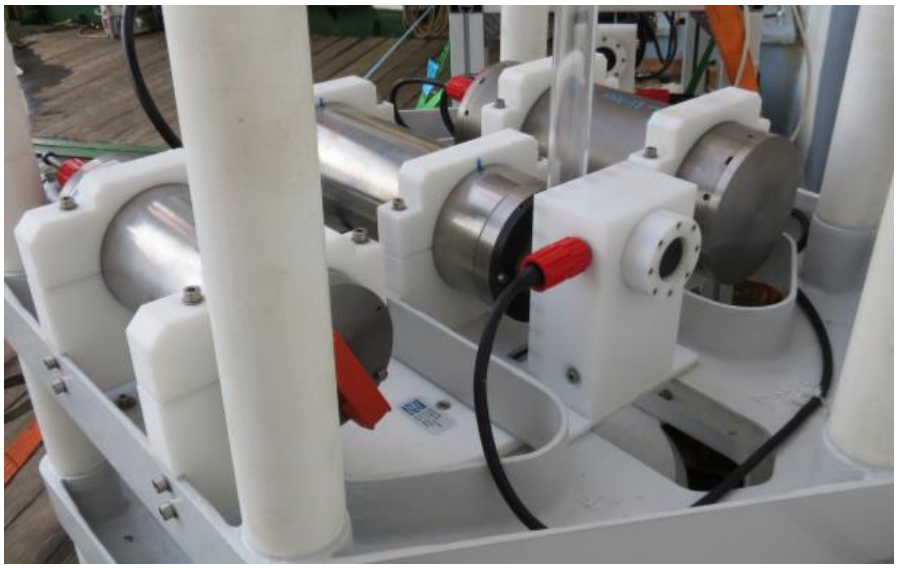

Fig. 3.5 The Camera System on the BOP with the camera housing in the middle (for camera, lens and system electronics), the VIS light source and the Li-Ion battery.

Table 3.8 Programming of the BOP system. Periodical measurements of the camera system for 5 minutes every day and changing of 40 gel cups in the sediment trap every 3 / 15.5 days alternately.

Date [yyyy-mm-dd]	Time [hh:mm:ss]	Remarks
2016-02-25	00:01:00	Trap: First bottom bottle
2016-02-25	12:00:00	Camera: auto start, 1 image per second for 5 minutes, auto shutdown, THIS PROCEDURE WILL BE REPEATED EVERY DAY WITHOUT END DATE
2016-02-28	00:01:00	Trap: Next bottom bottle
2016-03-14	12:01:00	Trap: Next bottom bottle
2016-03-17	12:01:00	Trap: Next bottom bottle
2016-04-05	00:01:00	Trap: Next bottom bottle
2016-04-08	00:01:00	Trap: Next bottom bottle
2016-04-26	12:01:00	Trap: Next bottom bottle
2016-02-29	12:01:00	Trap: Next bottom bottle
2016-05-18	00:01:00	Trap: Next bottom bottle
2016-05-21	00:01:00	Trap: Next bottom bottle
2016-06-08	12:01:00	Trap: Next bottom bottle
2016-06-11	12:01:00	Trap: Next bottom bottle
2016-06-30	00:01:00	Trap: Next bottom bottle
2016-07-03	00:01:00	Trap: Next bottom bottle
2016-07-21	12:01:00	Trap: Next bottom bottle
2016-07-24	12:01:00	Trap: Next bottom bottle
2016-08-12	00:01:00	Trap: Next bottom bottle
2016-08-15	00:01:00	Trap: Next bottom bottle
2016-09-02	12:01:00	Trap: Next bottom bottle
2016-09-05	12:01:00	Trap: Next bottom bottle
2016-09-24	00:01:00	Trap: Next bottom bottle
2016-09-27	00:01:00	Trap: Next top bottle
2016-10-15	12:01:00	Trap: Next top bottle
2016-10-18	12:01:00	Trap: Next top bottle
2016-11-06	00:01:00	Trap: Next top bottle
2016-11-09	00:01:00	Trap: Next top bottle
2016-11-27	12:01:00	Trap: Next top bottle
2016-11-30	12:01:00	Trap: Next top bottle
2016-12-19	00:01:00	Trap: Next top bottle
2016-10-22	00:01:00	Trap: Next top bottle
2017-01-09	12:01:00	Trap: Next top bottle
2017-01-12	12:01:00	Trap: Next top bottle
2017-01-31	00:01:00	Trap: Next top bottle
2017-02-03	00:01:00	Trap: Next top bottle
2017-02-21	12:01:00	Trap: Next top bottle
2017-02-24	12:01:00	Trap: Next top bottle
2017-03-15	00:01:00	Trap: Next top bottle
2017-03-18	00:01:00	Trap: Next top bottle
2017-04-05	12:01:00	Trap: Next top bottle
2017-04-08	12:01:00	Trap: Next top bottle
2017-04-27	00:01:00	Trap: Last bottle out; System open

3.5 Oceanography

3.5.1 Rosette with CTD-oxygen-fluorescence-turbidity probe and the Secchi disk

(Morten Iversen, Helga van der Jagt, Clara Flintrop, Eumni Park and Christian Konrad)

Background

We recorded ten vertical profiles with the shipboard Seabird CTD (see Table 3.9). The SBE-5-CTD was equipped with additional oxygen, turbidity, and fluorescence sensors and mounted on a rosette with 12 Niskin bottles, which each collected 8 L of water. Water samples were collected on all CTD-Rosette casts, except station GeoB20702-8. Water was used for incubations in roller tanks to form settling aggregates, for filtrations for particulate organic carbon, particulate organic nitrogen, chlorophyll*a*, DNA, and for up-concentrations of plankton cells larger than 25 µm. All samples will be processed in the home laboratory.

Table 3.9 List of Rosette-CTD (ROS + CTD) profiles and depths of water taken with the Niskin bottles of the rosette (ROS). Water samples were taken for studies of marine snow aggregation and organic and inorganic components of the particulate material through the water column.

Station No.	Latitude [N]	Longitude [W]	Water depth [m]	Water depths of samples [m]
GeoB20701-1	21°17.26'	20°51.58'	4176	1x23, 1x33, 1x43, 1x54, 1x60, 3x100, 2x200, 2x400 – CTD 1<1000 m
GeoB20702-6	20°53.60'	18°43.02'	2726	1x10, 1x20, 1x30, 1x 40, 1x50, 1x80, 1x160, 1x200, 1x250, 1x400, 1x600, 1x600, 1x1000, CTD <1000 m
GeoB20702-7	20°53.55'	18°42.91'	2610	1x15, 2x20, 3x26, 1x35, 1x39, 1x54, 1x64, 1x83, 1x103 – CTD <100 m
GeoB20702-8	20°53.55'	18°42.91'	2610	No samples taken – CTD <100 m
GeoB20703-1	20°49.57'	18°46.17'	2649	1x12, 2x20, 2x39, 2x59, 2x100, 1x200, 2x400, CTD <1000 m
GeoB20704-2	20°40.43'	18°15.72'	1294	3x50, 3x100, 3x150, 3x200 – CTD <1000 m
GeoB20705-3	20°52.35'	18°45.97'	2774	1x10, 1x20, 1x30, 4x40, 1x60, 1x80, 1x100, 1x300, 1x500 – CTD <1000 m
GeoB20706-2	20°55.82'	19°15.60'	3352	1x10, 5x25, 1x40, 1x80, 1x150, 1x300, 1x600, 1x1000 – CTD <1000 m
GeoB20707-3	20°39.87'	18°00.43'	854	1x10, 2x18, 1x30, 1x40, 1x60, 1x80, 1x90, 1x100, 1x150, 1x400, 1x700 – CTD <850 m
GeoB20710-1	20°38.16'	18°20.33'	1279	4x20, 1x60, 1x130, 1x300, 1x729, 1x850, 1x950 – CTD <1200 m

Preliminary Results

The vertical CTD profiles were obtained along a transect in an off-shore direction off Cape Blanc (Fig. 3.6). The different water layers were characterized by their temperature and salinity, showing a strong vertical temperature gradient at around 100 m, while a strong salinity gradient was observed in the upper 50 meters of the water column (Fig. 3.7, left panel). The peak in fluorescence was observed near the coastal station and indicates that strong upwelling of nutrient-rich deep water occurred here. We observed fairly high oxygen concentrations in the upper 100 m of the water column, which seemed well correlated to the higher fluorescence concentrations, suggesting that the high oxygen was a result of primary production (Fig 3.7, right panels). We additionally measured the Secchi depths to be around 15 m. We observed high turbidity in the surface ocean, most likely due to the presence of phytoplankton. In addition we also observed that the deeper waters had higher turbidity near the coast compared to the more off-shore stations. This was likely due to resuspension on the shelf and slope area caused by the upwelling waters (Fig. 3.8).

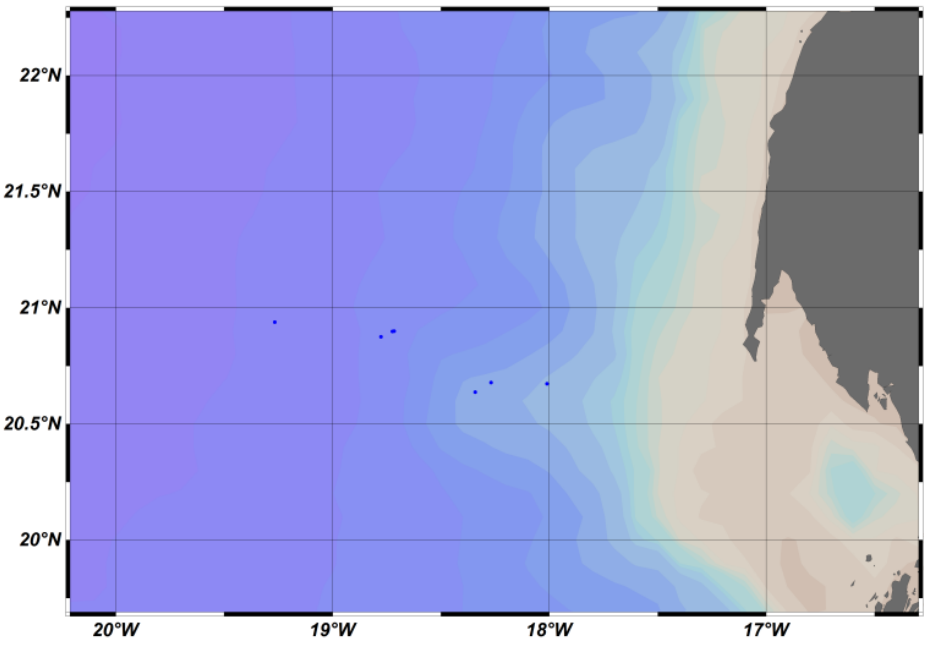

Fig. 3.6
Vertical CTD-profiles were obtained along a W-E transect off Cape Blanc, Mauritania. Blue circles indicate the sampling stations.

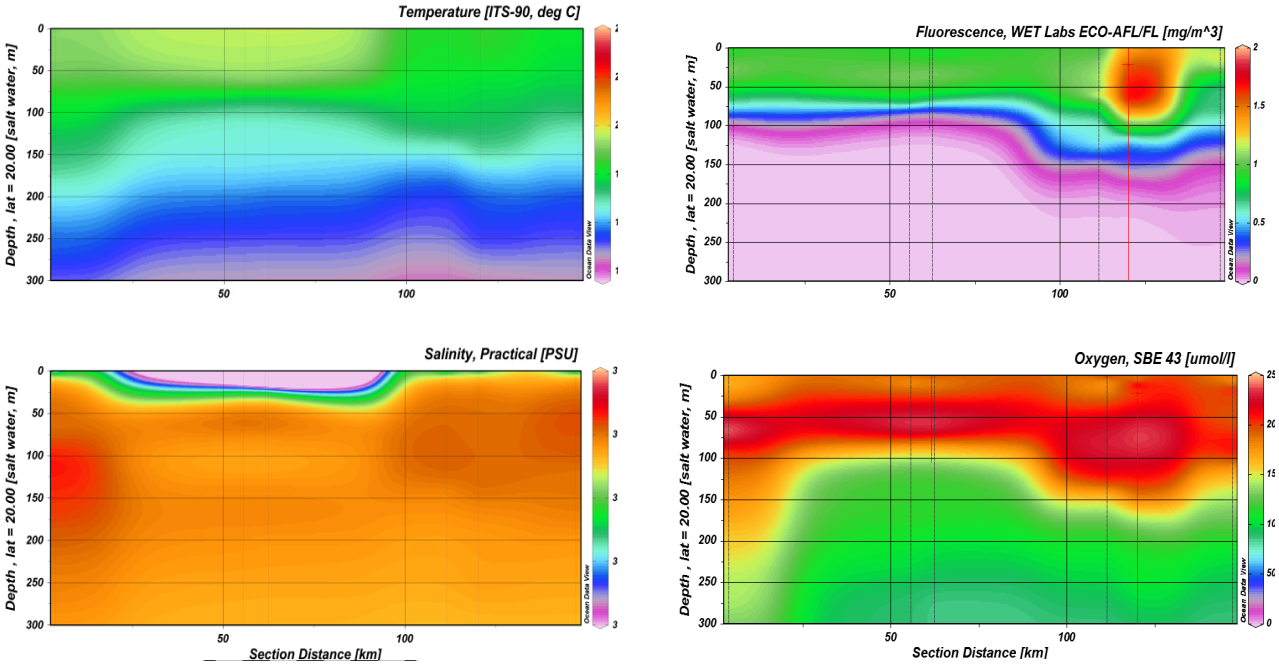

Fig. 3.7 Vertical profiles of temperature and salinity (both left panel), fluorescence and oxygen concentrations (both right panel) measured along an off-shore transect off Cape Blanc (see Fig. 3.6).

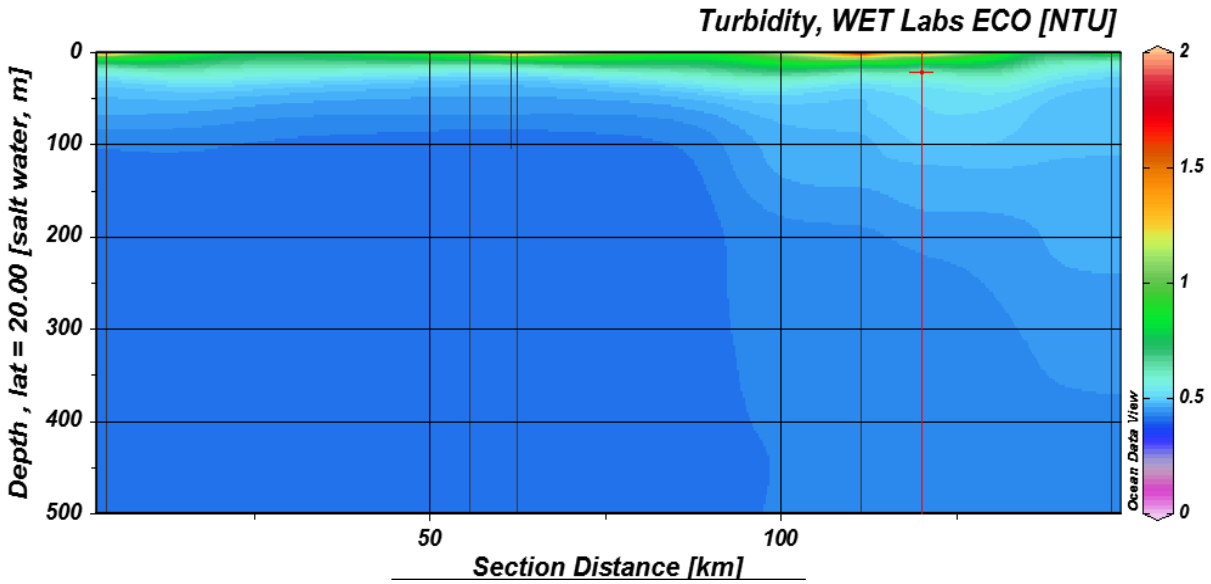

Fig. 3.8 Vertical profiles of turbidity (see vertical lines) along an off-shore transect off Cape Blanc shown in Fig. 3.6. Note the higher particle concentrations in the entire water column closer to the coast.

3.6 Marine Geology

3.6.1 Upper ocean particle flux measured with free-drifting particle traps

(Helga van der Jagt, Christian Konrad, Clara Flintrop, Götz Ruhland and Morten Iversen)

Background

Previous studies in the research area off Cape Blanc have shown that most biological activity from vertical migrating zooplankton in the epi- and upper mesopelagic determines the flux attenuation. Iversen et al. (2010) observed that zooplankton organisms migrate to shallow depths to feed during night and it seems that interactions between settling aggregates and zooplankton organisms have a large impact on the amount of exported material. This results in higher retention of settling particles during night. We hope to both capture some of these interactions and to follow to particle transformations from marine snow to zooplankton fecal pellets with the IRCam investigations.

Sampling

Each drifting trap array consisted of a surface buoy equipped with a an Iridium satellite unit and a AIS transmitter, four surface floats and 15 small fishery buoyancy balls serving as wave breakers to reduce the hydrodynamic effects on the sediment traps (Figs. 3.9, 3.10). The export fluxes through the upper 400 m of the water column were collected by free-drifting sediment traps. Each sediment trap collection depth (100, 200, and 400 m) had four gimbal mounted collection cylinders, each 1 m tall and 10.4 cm in inner diameter. Three of the collection cylinders at each depth served as standard bulk flux collectors and were filled with filtered sea water with a salinity of 40‰ before deployment. The remaining collection cylinder was filled with 200 ml of a viscous gel to intercept and preserve settling particles without destroying their original size and structure.

The bulk fluxes were preserved with $HgCl_2$ after recovery and will be used to determine mass fluxes of carbon, nitrogen, biogenic opal, calcium carbonate, and lithogenic material. The different particle types collected in the gel cylinder were photographed using a digital camera and will be used to create particle size distribution of the flux and to identify transformation processes between the different trap depths. In addition to the traditional sediment trap collections, we deployed an Infrared camera system (IRCam) at 50 m depth on the drifting array (Figs. 3.9 and 3.11; Table 3.10). The IRCam recorded one image per second throughout the whole deployment and will provide information about the diel particle transformations and dynamics at 50 m (chapter 3.4.1). Two deployments were carried out during the cruise (DF-13 and DF-14, Table 3.10).

Table 3.10 Overview of deployment and recovery dates for the two drifting sediment trap arrays DF-13 and DF-14.

Trap name	Deployment Recovery	LAT [N]	LON [W]	Time [UTC]	Equipment
DF-13	2016-02-22	20°53.28'	18°43.47'	14:34	Traps at 100, 200, 400m and
(GeoB20703-2)	2016-02-23	20°48.95'	18°47.17'	13:03	IRCam at 50m
DF-14	2016-02-25	20°38.22'	18°21.70'	13:42	Traps at 100, 200, 400m and
(GeoB20710-3)	2016-02-26	20°38.23'	18°24.63'	13:17	IRCam at 50m

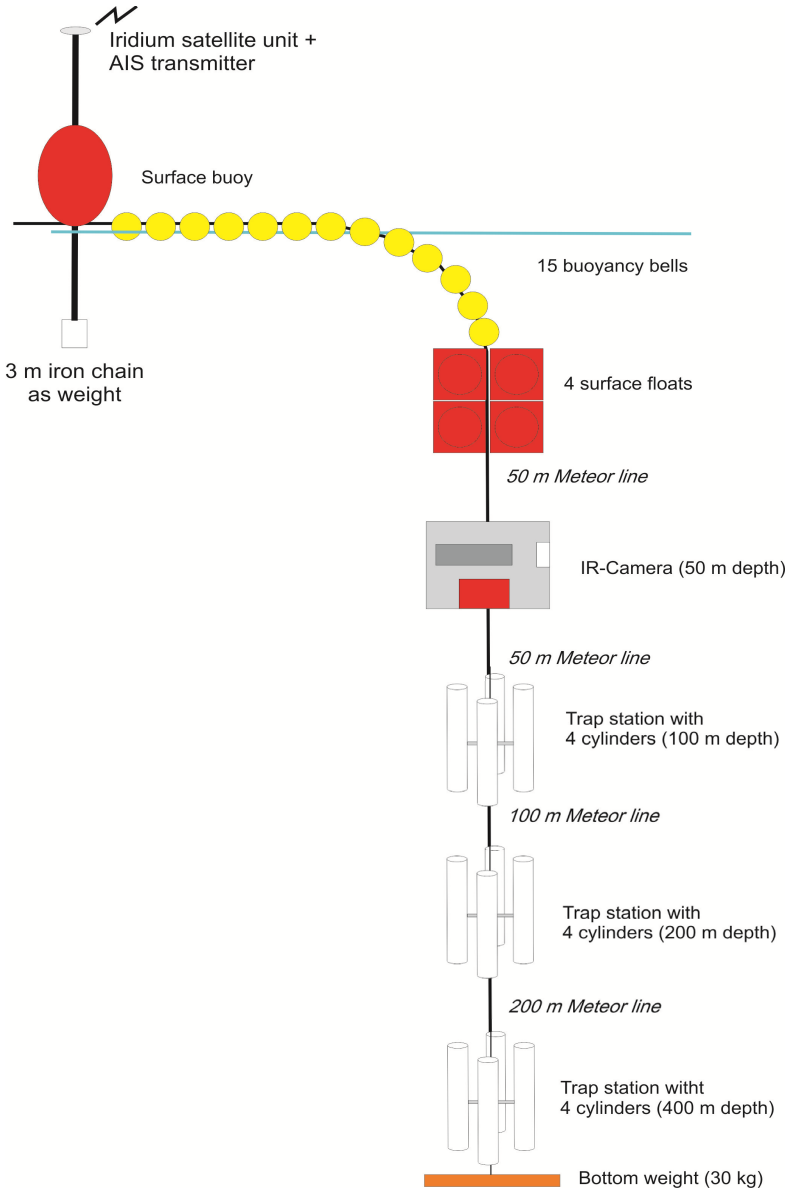

Fig. 3.9 Schematic of the deployments of the drifting arrays DF-13 and DF-14. Each array consisted of the IRCam deployed at 50 m and three sediment traps at 100, 200 and 400 m water depth (see also Table 3.10).

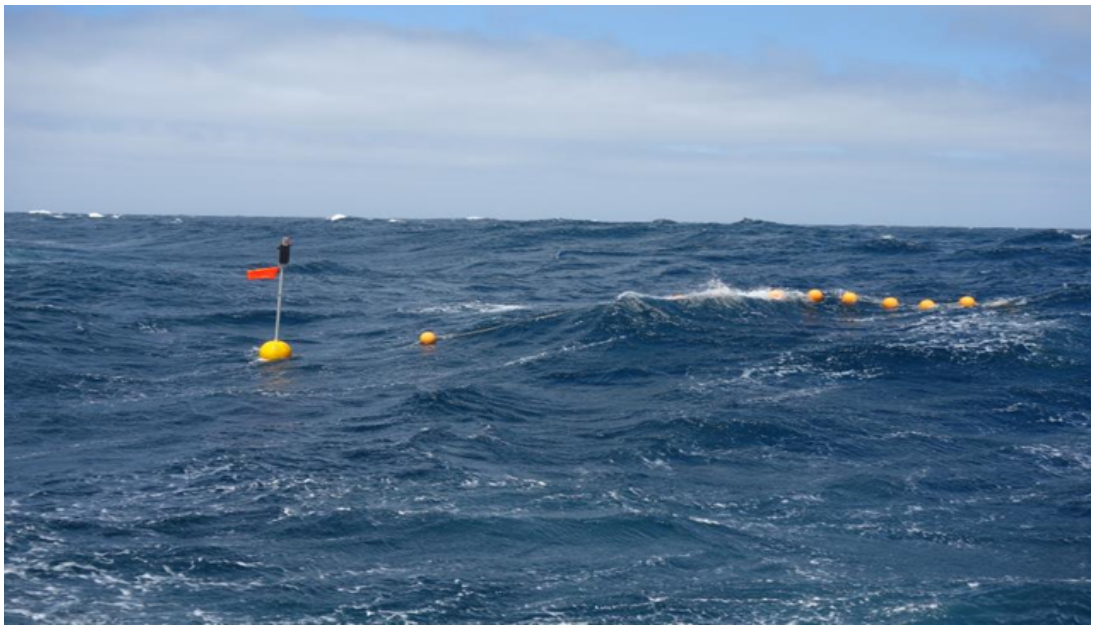

Fig. 3.10 Deployment of the drifting array DF-13. The top buoy with the Iridium satellite unit, the AIS transmitter and the orange buoyancy balls can be seen; the latter are used to dampen the wave action.

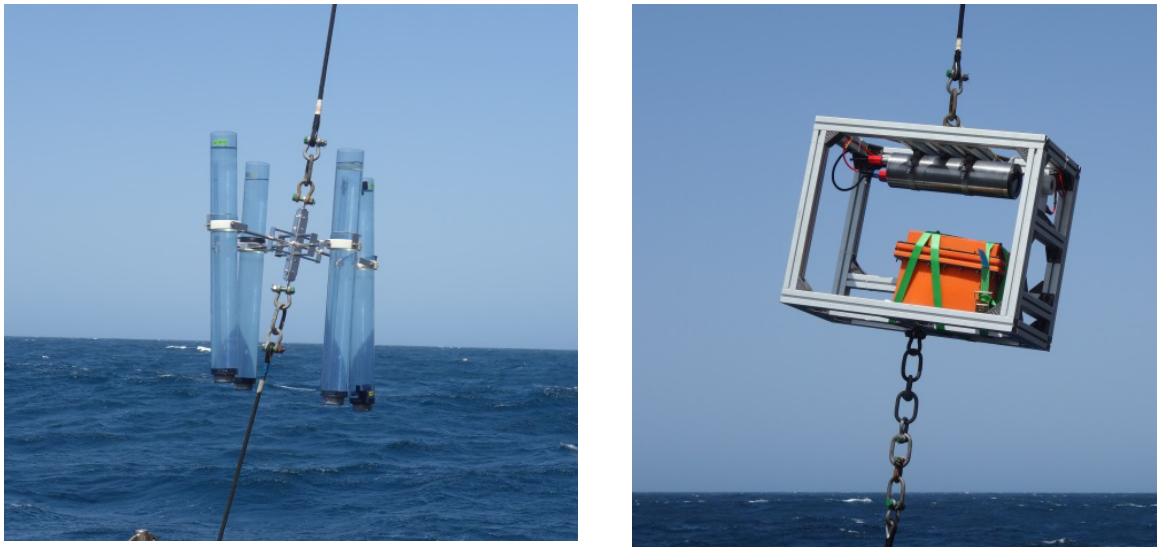

Fig. 3.11 Instruments deployed in the drifting arrays. Left: Cylindrical sediment trap, one of four filled with a cryogel. Right: The Infrared camera (IRCam) with camera housing and battery.

Preliminary Results

The majority of the settling particles collected in the gel traps seemed to be marine snow aggregates and zooplankton fecal pellets (Figs. 3.12 and 3.13). By combining the drifting trap measurements of export flux with the information about particle types, sizes, and abundances obtained from both the gel traps and the IRCam, we hope to

gain insight into how different degradation processes influenced the export during our deployment. Grazing on marine snow by zooplankton (chapter 3.2.1) can have several implications for the vertical flux; e.g. marine snow aggregates can be completely removed by ingestion of whole aggregates. Aggregate size can decrease due to fragmentation and partly ingestion and the sinking particles can be repacked from marine snow to fecal pellets. Both repackaging and changes in aggregate sizes will change the sinking velocity of the aggregates, either to slower velocities, in case of fragmentation and partly ingestion, or potentially, higher velocities when repackaged into dense fecal pellets. Hereby, the retention time of sinking particles in the upper water column may be strongly influenced by the presence of zooplankton. By investigating the composition of vertical fluxes at different depths in the upper water column, we hope to observe and understand the processes responsible for the transformation and degradation of sinking particles.

A first glimpse into the material collected in the gel traps showed that fecal pellets especially from copepods were common in the exported material but that marine snow aggregates seemed to make up a large part of the exported material as well (Figs. 3.12 and 3.13).

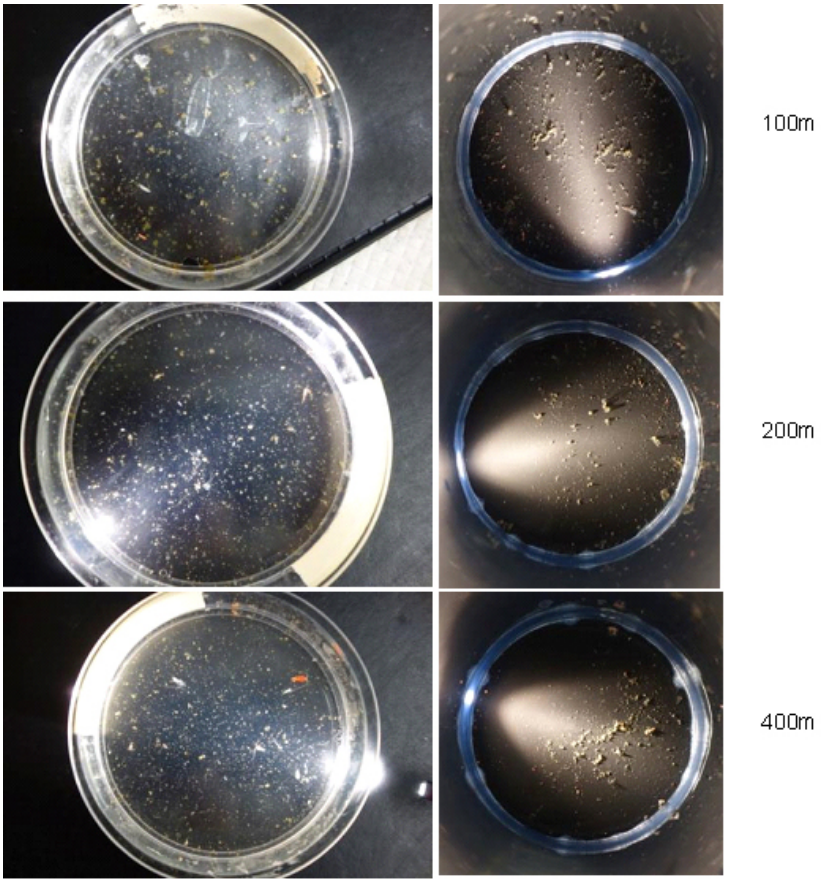

Fig. 3.12 Drifting trap DF-13. Images of the gel traps (left column) and of one of the three trap cylinders without gel (right side) from the three collection depths; 100, 200, and 400 m (Table 3.10).

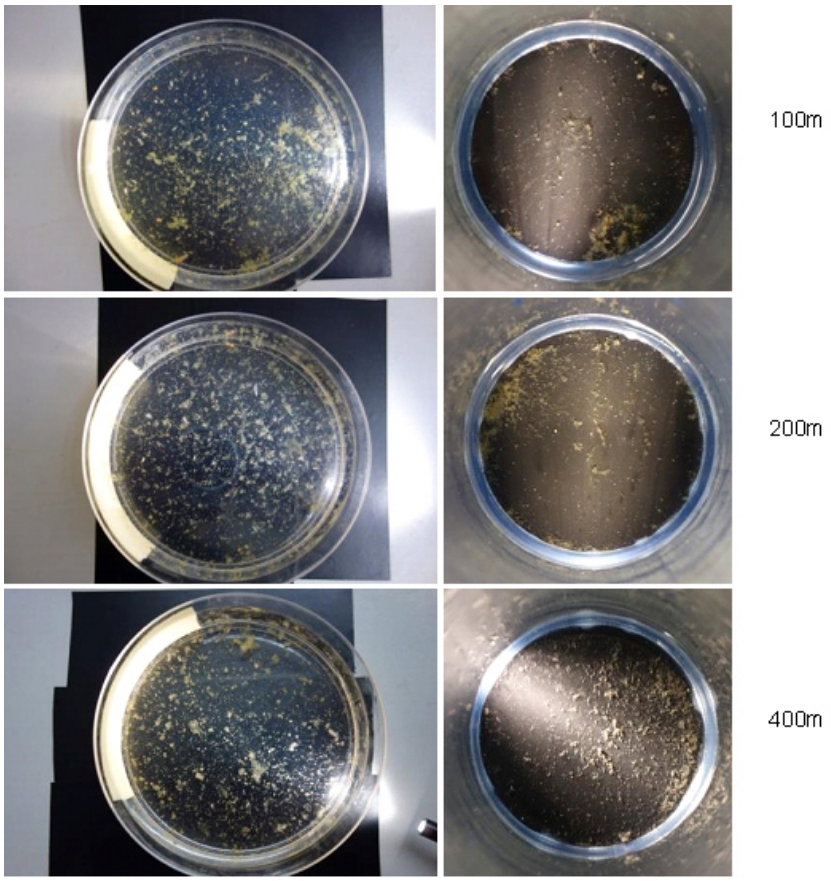

Fig. 3.13 Drifting trap DF-14. Images of the gel traps (left column) and of one of the three trap cylinders without gel (right side) from the three collection depths; 100, 200, and 400 m (Table 3.10).

3.6.2 Seasonal and interannual particle fluxes measured with moored sediment traps

(Götz Ruhland, Marco Klann, Daniel Hüttich and Gerhard Fischer)

Background

Meanwhile, we have a long-term mass flux record from the mesotrophic study site CB starting in 1988 (Fischer et al., 2016) and from the eutrophic site CBi from 2003 onwards. Both sites are situated with in the ‘giant Cape Blanc filament (Van Camp et al., 1991) and were designed to monitor the long term (intradecadal to decadal) flux variability as well as potential trends in fluxes due to some climatic forcing or

anthropogenic issues (e.g. 'Bakun coastal upwelling intensification hypothesis', Bakun, 1990; Cropper et al., 2014).

Sampling

The mesotrophic mooring position CB is located about 210 nm off Cape Blanc (Mauritania) and is operated since 1988 as long term study site. It is situated in a mesotrophic area at the edge of the Cape Blanc filament in about 4150 m water depth. The mooring array is used to monitor the long-term change of particle fluxes in the Mauritanian offshore upwelling zone. Another mooring named CBi-13 was deployed during the Poseidon POS-481 cruise around 120 nm further to the east and was also planned to be exchanged (CBi-13/14). The data of deployments and recoveries of the moorings are listed in Table 3.11 alongside with the sampling data of the traps.

Table 3.113 Data for recoveries and redeployments of the sediment particle trap mooring arrays. The eutrophic site CBi-14 is equipped with the Bio-Optical Platform (BOP, chapter 3.4.2).

Mooring	Position	Water Depth [m]	Interval	Instr.	Depth [m]	Intervals [no. x days]
Mooring recoveries:						
Cape Blanc mesotrophic:						
CB-26	21°17.26'N	4176	23.02.15-	SMT234NE	1232	20x18d
GeoB20701-1	20° 51.58'W		18.02.16	SMT234NE	3638	-------
Cape Blanc eutrophic:						
CBi-13	20° 53.19'N	2740	27.02.15-	SMT234NE	1346	1x 14d, 19x 18d
GeoB20702-1	18° 43.95'W		18.02.16	SMT234NE	1903	1x 14d, 19x 18d
Mooring deployments:						
Cape Blanc mesotrophic						
CB-27	21°12.82'N	4154	22.02.16-	SMT243NE	1201	20x21.5d
	20° 52.14'W		27.04.17	SMT234NE	3616	20x21.5d
Cape Blanc eurtrophic						
CBi-14	20° 52.46'N	2750	25.02.16-	BOP	1251	
	18° 44.74'W		27.04.17	SMT234NE	1356	1x 18.5d, 19x 21.5d
				SMT234NE	1913	1x 18.5d, 19x 21.5d

Instruments used:

SMT234 NE = particle trap, KUM, Kiel
SMT243 NE = particle trap (Titanium), KUM, Kiel
BOP = Bio-Optical Platform

Preliminary Results

After the transit time from Las Palmas, the mooring CB-26 off Cape Blanc was successfully recovered in the afternoon of February 20th, 2016. This recovery

happened just two days after closing the last sample cup. The upper particle trap delivered a complete sample set of 20 cups. The lower trap was programmed on the same schedule. Unfortunately due to a malfunction the sampling carousel stayed on the first sampling position. Due to the upside down recovery of the trap this sample was partly lost. The mooring was redeployed as CB-27 with a similar configuration in the afternoon of the next day (February 21st, 2016).

In the morning of February 22nd, 2016, the 1500 m long mooring array CBi-13 was released in the coastal part of the Cape Blanc filament. This mooring was equipped with two particle traps each with a sampling carousel of twenty bottles. Two complete sets of samples of CBi-13 could be received, each with 20 samples due to the programming schedule of the traps. In the morning of February 24th, the mooring array CBi-14 could be redeployed with a comparable set of devices. Additionally a the Bio-Optical Platform (BOP) with particle camera and gel-filled sampling cups has been installed above the upper particle trap (Fig. 3.14; chapter 3.4.2). The BOP partly replaces the former Multi-Sensor Platform (MSP, Report 307, Fischer et al., 2015) which was equipped with optical instruments and CTD (Nowald et al., 2015). It is planned to recover and redeploy these moorings with R/V POSEIDON in spring 2017.

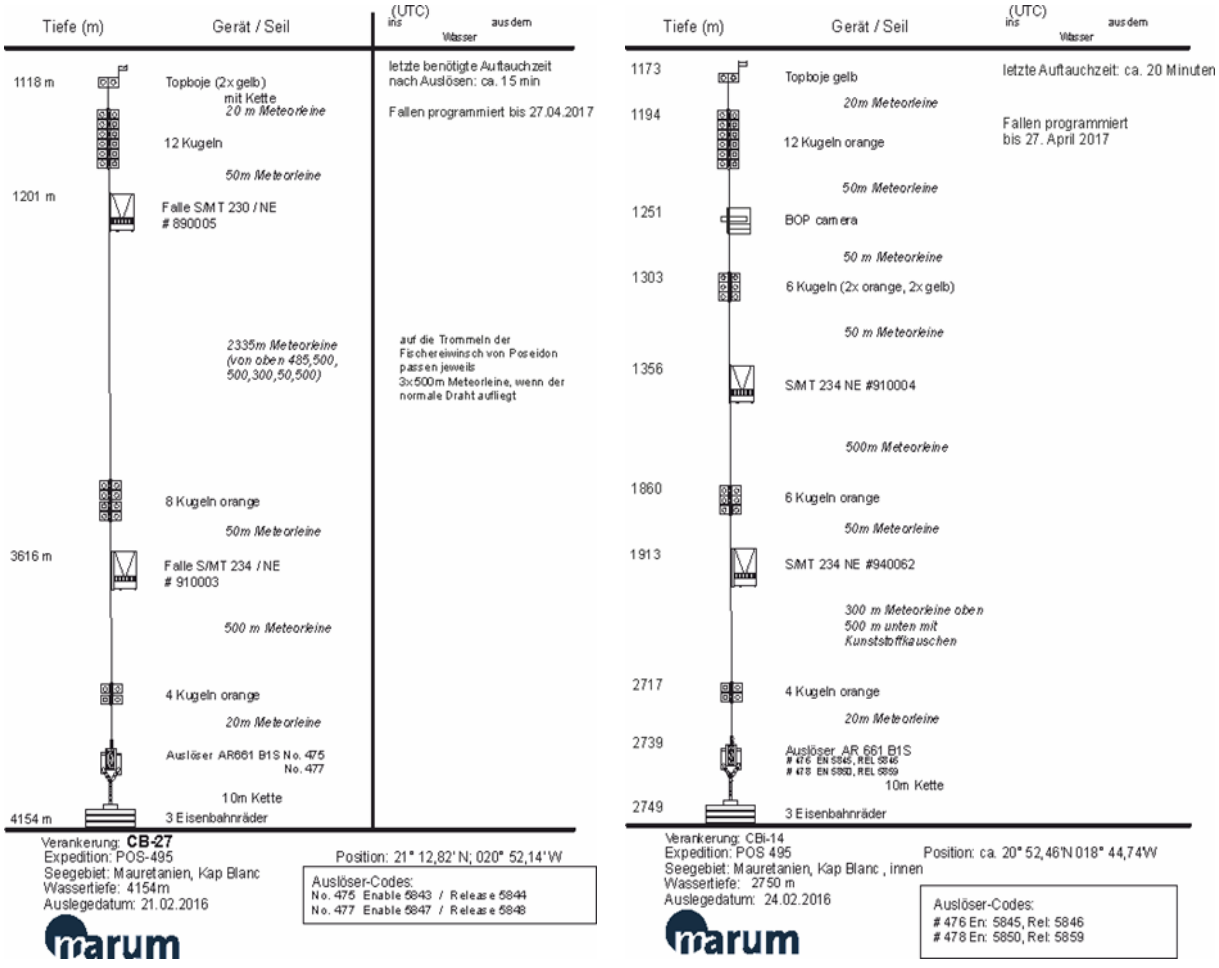

Fig. 3.14 Drawings of the mooring array CB-27 (mesotrophic) and CBi-14 (eutrophic, with BOP) deployed during the cruise. Recoveries are planned for spring 2017 with R/V POSEIDON.

4 Station List

GeoB…	Ships Stat. No [POS495_...]	Date 2016 [dd.m.]	Device	Time at seafloor/ max. wire length [UTC]	Latitude [N]	Longitude [W]	Water depth [m]	Recovery/Remarks
20701-1	28/1	20.2.	CB-26	13:08	21°17.26'	20°51.58'	4176	Release and recovery of sediment trap mooring upper trap ok (20 samples), lower #1 bulk sample
20701-2	29/1		ROS+CTD	17:15	21°18.46'	20°51.94'	4193	Down to 1000m, samples: 2x400, 2x200, x100, 1x60, 1x54, 1x43, 1x33, 1x23m
20701-3	29/2		IRCam	18:26	21°18.57'	20°52.50'	4185	Test down to 20m, test
20701-4	29/3		IRCam	19:33	21°18.74'	20°53.12'	4183	Profile down to 1000m, 0.5 m per sec
20701-5	29/4		MSC	20:48	21°18.97'	20°53.77'	4186	Down to 25m
20701-6	29/5		HN	21:00	21°19.02'	20°53.88'	4208	Down to 50m
20701-7	29/6	20./21.2.	IRCam	21:19	21°19.07'	20°54.04'	4208	Down to 100m, overnight until 09:00 (21.2.)
20701-8	29/7	21.2.	IRCam	10:34	21°23.91'	20°58.52'	4227	Profile down to 1000m, 0.5m per sec
20701-9	29/8		MN	11:29	21°23.85'	20°58.66'	4226	Down to 300m: 300-150, 150-100, 100-80, 80-40, 40-0m
20701-10	29/9		Secchi	11:53	21°23.89'	20°58.67'	4235	14.5 m Secchi depth
20701-11	30/1		CB-27	16:01	21°12.82'	20°52.14'	4154	Deployment of mooring with two sediment traps
20702-1	31/1	22.2.	CBi-13	08:10	20°53.19'	18°43.95'	2740	Recovery of the sediment trap mooring, both traps with 20 samples
20702-2	32/1		MN	10:32	20°53.48'	18°43.85'	2744	Down to 300m: 300-150, 150-100, 100-80, 80-40, 40-0m
20702-3	32/2		IRCam	11:46	20°53.51'	18°43.52'	2743	Down to 1000m
20702-4	32/3		Secchi	12:37	20°53.55'	18°43.59'	2695	9.0 m Secchi depth
20702-5	32/4		DF-13	14.34	20°53.28'	18°43.47'	2733	Deployment of drifting array: IRCam in 50, traps in 100, 200, 400m
20702-6	33/1		ROS+CTD	15:55	20°53.60'	18°43.02'	2726	Down to 1000m: samples in 1000, 600, 400, 250, 200, 160, 80, 50, 40, 30, 20, 10m
20702-7	33/2		ROS+CTD	17:15	20°53.55'	18°42.91'	2610	Down to 100m
20702-8	33/2		ROS+CTD		20°53.55'	18°42.91'	2610	Down to 100m
20702-9	33/3		MSC	18:28	20°53.54'	18°42.89'	2723	Down to 30m
20702-10	33/4		HN	19:57	20°53.55'	18°42.86'	2727	Down to 50m
20702-11	33/5		HN	20:05	20°53.52'	18°42.84'	2724	Down to 50m
20702-12	33/6		MN	20:26	20°53.49'	18°42.85'	2731	Down to 300m: 300-150, 150-100, 100-80, 80-40, 40-0m
20702-13	33/7	22./23.2.	ISP	21:22	20°53.42'	18°42.84'	2681	4 pumps deployed overnight: (40), 80, 160, 250m
20703-1	34/1	23.2.	ROS+CTD	09:09	20°49.57'	18°46.17'	2649	Down to 1000m: samples in: 2x400,200,2x100,2x59,2x39,2x20,12m
20703-2	35/1		DF-13	13:00	20°48.98'	18°47.14'	2803	Recovery start of array with IRCam and 3 cylindrical traps
20703-3	35/2		IRCam	14:38	20°49.09'	18°47.06'	2798	Down to 1000m

GeoB…	Ships Stat. No [POS495_...]	Date 2016 [dd.m.]	Device	Time at seafloor/ max. wire length [UTC]	Latitude [N]	Longitude [W]	Water depth [m]	Recovery/Remarks
20704-1	36/1	23.2	IRCam	20:51	20°40.14'	18°15.33'	1270	Down to 1000m
20704-2	36/2		ROS+CTD	22:03	20°40.43'	18°15.72'	1294	Down to 1000m, samples in 3x200,3x150,3x100,3x50m
20704-3	36/3	23./24.2	ISP	23:02	20°40.61'	18°16.15'	1324	3 pumps deployed overnight: 50,100, 200m
20705-1	37/1	24.2.	CBi-14	15:27	20°52.46'	18°44.74'	2750	Deployment with BOP and 2 sediment traps
20705-2	38/1		IRCam	16:38	20°52.38'	18°45.93'	2776	Down to 1000m
20705-3	38/2		ROS +CTD	17:39	20°52.35'	18°45.97'	2774	Down to 1000m: samples in 500,300,100,80,60,4x40,30,20,10m
20705-4	38/3		MSC	19:20	20°52.37'	18°45.94'	2771	Down to 20m
20705-5	38/4		HN	19:44	20°52.35'	18°45.96'	2779	Down to 20m
20705-6	38/5		HN	19:56	20°52.26'	18°45.95'	2771	Down to 50m
20705-7	38/6	24./25.2	ISP	20:26	20°52.22'	18°45.83'	2763	3 pumps deployed overnight: 40,300,500m
20706-1	39/1	25.2	IRCam	12:51	20°55.44'	19°15.25'	3339	Down to 1000m (normal light, test)
20706-2	39/2		ROS+CTD	13:58	20°55.82'	19°15.45'	3352	Down to 1000m: samples in 1000, 600,300,150,80,40,5x25,10m
20706-3	39/3		IRCam	15:39	20°56.41'	19°15.60'	3358	Down to 1000m (infrared light)
20707-1	40/1	26.2	IRCam	08:42	20°40.08'	18°00.59'	871	Down to 850m
20707-2	40/2		MN	09:32	20°39.90'	18°00.53'	861	Down to 300m: 300-150, 150-100, 100-80, 80-40, 40-0m
20707-3	40/3		ROS+CTD	10:28	20°39.87'	18°00.43'	854	Down to 850m: samples in 700,400,150,100,90,80,60,40,30,2x18,10m
20707-4	40/4		Secchi	11:12	20°39.79'	18°00.53'	857	Secchi depth in 12.5m
20708-1	41/1		DF-14	13:38	20°39.93'	18°15.08'	1267m	Deployment of drifting array: IRCam in 50m, traps in 100, 200, 400m
20709-1	42/1		MSC	16:16	20°39.77'	18°00.48	854	Down to 30m
20709-2	42/2		HN	20:06	20°40.03'	18°00.61'	870	Down to 50m
20709-3	42/3	26.2	HN	20:16	20°39.96'	18°00.60'	867	Down to 50m
20709-4	42/4	26./27.2	ISP	20:41	20°39.81'	18°00.59'	860	3 pumps deployed overnight in: 18, 150, 400m
20710-1	43/1	27.2	ROS+CTD	11:29	20°38.16'	18°20.33'	1279	Down to 1200m: samples in 950,850,729,300,130,60,4x20m
20710-2	43/2		Secchi	12:31	20°38.50'	18°20.44'	1298	Secchi depth in 12.5m
20710-3	44/1		DF-14	13:16	20°38.22'	18°21.63'	1306	Recovery of drifting array with IRCam and 3 cylindrical traps
20710-4	44/2		IRCam	14:46	20°38.34'	18°21.70'	1316	Down to 1200m

Instruments/Devices used:

CB-26/27	mesotrophic sediment trap moorings off Cape Blanc, Mauritania
CBi-13/14	eutrophic sediment trap mooring, CBi-14 with BOP (Bio-Optical Platform)
DF-13-14	Drifting trap, each with 3 traps and one IRCam at 50m in the epi- and mesopelagic
ROS + CTD	Multi-water sampler (rosette) with 12 x 10l bottles and CTD-SBE 5 (Geomar), with turbidity sensor
MSC	Marine Snow Catcher (100 l volume)
IRCam	Particle Camera System with infrared light, profiling and deployment modes (in drifting arrays DF-13/14)
ISP:	*in situ*-pumps (4/3 at maximum)
MN:	multinet (5 depth ranges) with 200µm mesh size, standard depths: 300-150,150-100,100-80,80-40,40-0m
HN	handnet (75µm), generally lowered down to 50m
Secchi disc	Secchi depth/transparency

5 Acknowledgements

This cruise was funded by the DFG Research Center and the Excellence Cluster at MARUM, University of Bremen. The R/V POSEIDON was again a perfect platform to perform our yearly time-series and process studies, including some testing of newly developed optical instruments. We thank Captain M. Günther and his entire crew for their professional and excellent support during the cruise. We are also indebted to the German authorities for foreign affairs in Berlin, Rabat (Morocco) and Nouakchott (MRT) that supported us to get research permissions during the planning phase of the cruise.

6 References

Bakun, A. (1990) Global climate change and intensification of coastal ocean upwelling. Science 247, 198-201.

Cropper, T.E., Hanna, E., Bigg, G.R., (2014) Spatial and temporal seasonal trends in coastal upwelling off Northwest Africa, 1981–2012. Deep-Sea Research II 86, 94–111.

Fischer, G. and G. Karakas (2009) Sinking rates and ballast composition of particles in the Atlantic Ocean: implications for the organic carbon fluxes to the deep ocean. Biogeosciences, 6, 85-102.

Fischer, G. and cruise participants. (2015) Report and preliminary results of R/V POSEIDON cruise POS 495. Las Palmas (Canary Islands) – Las Palmas (Canary Islands). 15.02.2015 – 03.03.2015. Berichte Marum – Fachbereich Geowissenschaften, No. 307, 33 pages, 2015.

Fischer, G., Iversen, M., Nowald, N., Reuter, C., Ruhland, G., Ratmeyer, V., Klann, M. and G. Wefer (2016) Deep ocean particle flux in the coastal upwelling off Mauritania from 1988 to 2012: variability on seasonal to decadal timescales. Biogeosciences, 13, 3071-3090.

Friese, C. et al. (2016) Environmental factors controlling the seasonal variation in particle size of modern Saharan dust deposited offshore Cape, Blanc. Aeolian Res., in press 2016,

Iversen, M.H., Ploug, H. (2010) Ballast minerals and the sinking carbon flux in the ocean: carbon-specific respiration rates and sinking velocity of marine snow aggregates. Biogeosciences 7, 2613-2624.

Nowald, N., Iversen, M.-H., Fischer, G., Ratmeyer, V. Wefer, G. (2015) Time series of in-situ particle properties and sediment trap fluxes in the coastal upwelling filament off Cape Blanc, Mauritania. Prog Oceanogr., http://dx.doi.org/10.1016/j.pocean.2014.12.015

Van Camp, L., Nykjaer, L., Mittelstadt, E. and P. Schlittenhardt (1991) Upwelling and boundary circulation off Northwest Africa as depicted by infrared and visible satellite observations, Progress in Oceanography, 26, 357-402.

From report No. 289 onwards this series is published under the new title:
Berichte aus dem MARUM und dem Fachbereich Geowissenschaften der Universität Bremen
A complete list of all publications of this series from no. 1 to 292 (1986 – 2012) was printed at last in issue no. 292.

No. 289 – Mohtadi, M. and cruise participants (2012). Report and preliminary results of RV SONNE Cruise SO 223T. TransGeoBiOc. Pusan – Suva, 09.09.2012 – 08.10.2012. 47 pages.
No. 290 – Hebbeln, D., Wienberg, C. and cruise participants (2012). Report and preliminary results of R/V Maria S. Merian cruise MSM20-4. WACOM – West-Atlantic Cold-water Corals Ecosystems: The West Side Story. Bridgetown – Freeport, 14 March – 7 April 2012. 120 pages.
No. 291 – Sahling, H. and cruise participants (2012). R/V Heincke Cruise Report HE-387. Gas emissions at the Svalbard continental margin. Longyearbyen – Bremerhaven, 20 August – 16 September 2012. 170 pages.
No. 292 – Pichler, T., Häusler, S. and Tsuonis, G. (2013). Abstracts of the 3rd International Workshop "Research in Shallow Marine and Fresh Water Systems". 134 pages.
No. 293 – Kucera, M. and cruise participants (2013). Cruise report of RV Sonne Cruise SO-226-3. Dip-FIP - The extent and structure of cryptic diversity in morphospecies of planktonic Foraminifera of the Indopacific Warm Pool. Wellington – Kaohsiung, 04.03.2013 - 28.03.2013. 39 pages.
No. 294 – Wienberg, C. and cruise participants (2013). Report and preliminary results of R/V Poseidon cruise P451-2. Practical training cruise onboard R/V Poseidon - From cruise organisation to marine geological sampling: Shipboard training for PhD students on R/V Poseidon in the Gulf of Cádiz, Spain. Portimao – Lisbon, 24 April – 1 May 2013. 65 pages.
No. 295 – Mohtadi, M. and cruise participants (2013). Report and preliminary results of R/V SONNE cruise SO-228, Kaohsiung-Townsville, 04.05.2013-23.06.2013, EISPAC-WESTWIND-SIODP. 107 pages.
No. 296 – Zonneveld, K. and cruise participants (2013). Report and preliminary results of R/V POSEIDON cruise POS448. CAPRICCIO – Calabrian and Adriatic Past River Input and Carbon ConversIOn In the Eastern Mediterranean. Messina – Messina, 6 – 23 March 2013. 47 pages.
No. 297 – Kopf, A. and cruise participants (2013). Report and preliminary results of R/V SONNE cruise SO222. MEMO: MeBo drilling and in situ Long-term Monitoring in the Nankai Trough accretionary complex, Japan. Leg A: Hong Kong, PR China, 09.06.2012 – Nagoya, Japan, 30.06.2012. Leg B: Nagoya, Japan, 04.07.2012 – Pusan, Korea, 18.07.2012. 121 pages.
No. 298 – Fischer, G. and cruise participants (2013). Report and preliminary results of R/V POSEIDON cruise POS445. Las Palmas – Las Palmas, 19.01.2013 – 01.02.2013. 30 pages.
No. 299 – Hanebuth, T.J.J. and cruise participants (2013). CORIBAR – Ice dynamics and meltwater deposits: coring in the Kveithola Trough, NW Barents Sea. Cruise MSM30. 16.07. – 15.08.2013, Tromsø (Norway) – Tromsø (Norway). 74 pages.
No. 300 – Bohrmann, G. and cruise participants (2014). Report and Preliminary Results of R/V POSEIDON Cruise P462, Izmir – Izmir, 28 October – 21 November, 2013. Gas Hydrate Dynamics of Mud Volcanoes in the Submarine Anaximander Mountains (Eastern Mediterranean). 51 pages.
No. 301 – Wefer, G. and cruise participants (2014). Report and preliminary results of R/V SONNE Cruise SO219A, Tohoku-Oki Earthquake – Japan Trench, Yokohama – Yokohama, 08.03.2012 – 06.04.2012. 83 pages.
No. 302 – Meinecke, G. (2014). HROV: Entwicklung und Bau eines hybriden Unterwasserfahrzeugs – Schlussbericht. 10 pages.
No. 303 – Meinecke, G. (2014). Inverse hydroakustische USBL-Navigation mit integrierter Kommunikation – Schlussbericht. 10 pages.
No. 304 – Fischer, G. and cruise participants (2014). Report and preliminary results of R/V POSEIDON cruise POS464, Las Palmas (Canary Islands) – Las Palmas (Canary Islands), 03.02.2014 – 18.02.2014. 29 pages.
No. 305 – Heuer, V.B. and cruise participants (2014). Report and preliminary results of R/V POSEIDON cruise POS450, DARCSEAS II – Deep subseafloor Archaea in the Western Mediterranean Sea: Carbon Cycle, Life Strategies, and Role in Sedimentary Ecosystems, Barcelona (Spain) – Malaga (Spain), April 2 – 13, 2013. 42 pages.
No. 306 – Bohrmann, G. and cruise participants (2015). Report and preliminary results of R/V METEOR cruise M112, Dynamic of Mud Volcanoes and Seeps in the Calabrian Accretionary Prism, Ionian Sea, Catania (Italy) – Catania (Italy), November 6 – December 15, 2014. 217 pages.
No. 307 – Fischer, G. and cruise participants (2015). Report and preliminary results of R/V POSEIDON cruise POS481, Las Palmas (Canary Islands) – Las Palmas (Canary Islands), 15.02.2015 – 03.03.2015. 33 pages.
No. 308 – Wefer, G. and Freudenthal, T. (2016). MeBo200 – Entwicklung und Bau eines ferngesteuerten Bohrgerätes für Kernbohrungen am Meeresboden bis 200 m Bohrteufe, Schlussbericht. 9 pages.
No. 309 – Sahling, H. and cruise participants (2016). R/V POSEIDON cruise POS498, Recovery of Observatories at Athina Mud Volcano, Izmir (Turkey) – Catania (Italy), 18 April – 1 May, 2016. 63 pages.
No. 310 – Fischer, G. and cruise participants (2016). Report and preliminary results of R/V POSEIDON cruise POS495, Las Palmas (Canary Islands) – Las Palmas (Canary Islands), 18.02.2016 – 02.03.2016. 29 pages.